



CHIST-ERA Projects Seminar Paris, 11-12 April 2018

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i Informàtica Industrial



CSIC

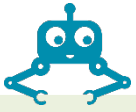


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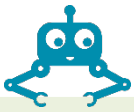
Bristol Robotics Laboratory





Outline

- Scientific background
- Key challenges and potential impact
- Consortium
- Main results
- Future work

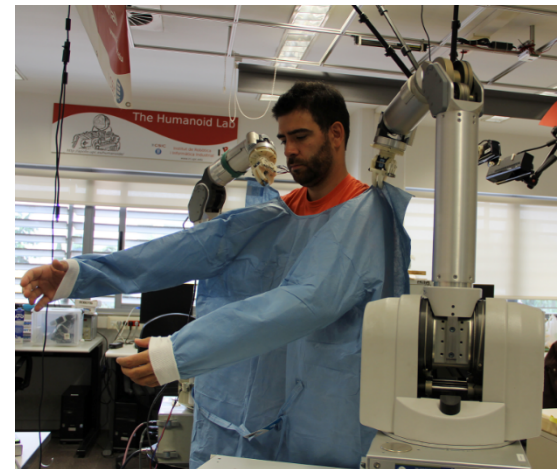


Scientific background

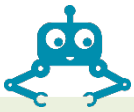
- **Full title:** Assistive interactive robotic system for support in dressing (I-DRESS)
- **Duration:** December 1, 2015 – November 30, 2018
- **Call:** (2014) Resilient Trustworthy Cyber-Physical Systems (RTCPS)
- **Overall goal:** Develop a robotic system that will provide proactive assistance with the dressing task.
- **Applications scenarios:**



Shoe (single arm)

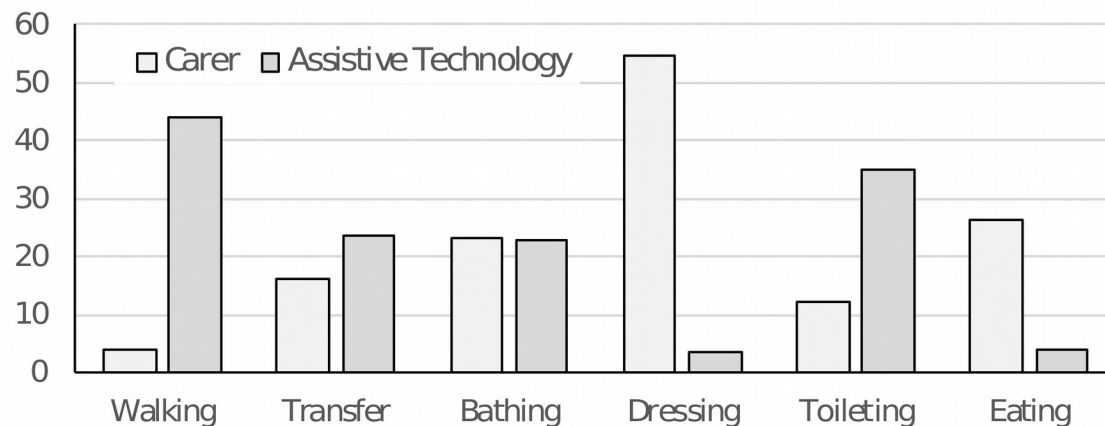


Jacket or gown (dual arm)



Scientific background

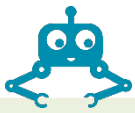
- Between 2000 and 2050, the proportion of the world's **population of over 60 years** is expected to double (WHO, 2016)
- Need for assistance with **activities of daily living (ADLs)**



- Of all the ADLs, **dressing** showed the **highest burden** on caregiving staff and the **lowest use of assistive technologies** (Dudgeon et al., 2008).

WHO. (2016). *Facts about Ageing*.

Dudgeon et al. (2008). *Managing Activity Difficulties at Home: A Survey of Medicare Beneficiaries*, *Arch Phys Med Rehabil*. 89(7):1256-1261.



Scientific background

■ Relevant work



T-shirt



Vest



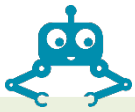
Trousers



Scarf



Hat



Key challenges and potential impact

■ Specific objectives:

- Detection and tracking of user and garments (WP2)
- Human-robot interaction framework (WP3)
- Learning from Demonstration algorithms (WP4)
- Safety through hazard analysis (WP5)
- Human factors (WP6)
- Integration on a commercial robotic platform (WP7)



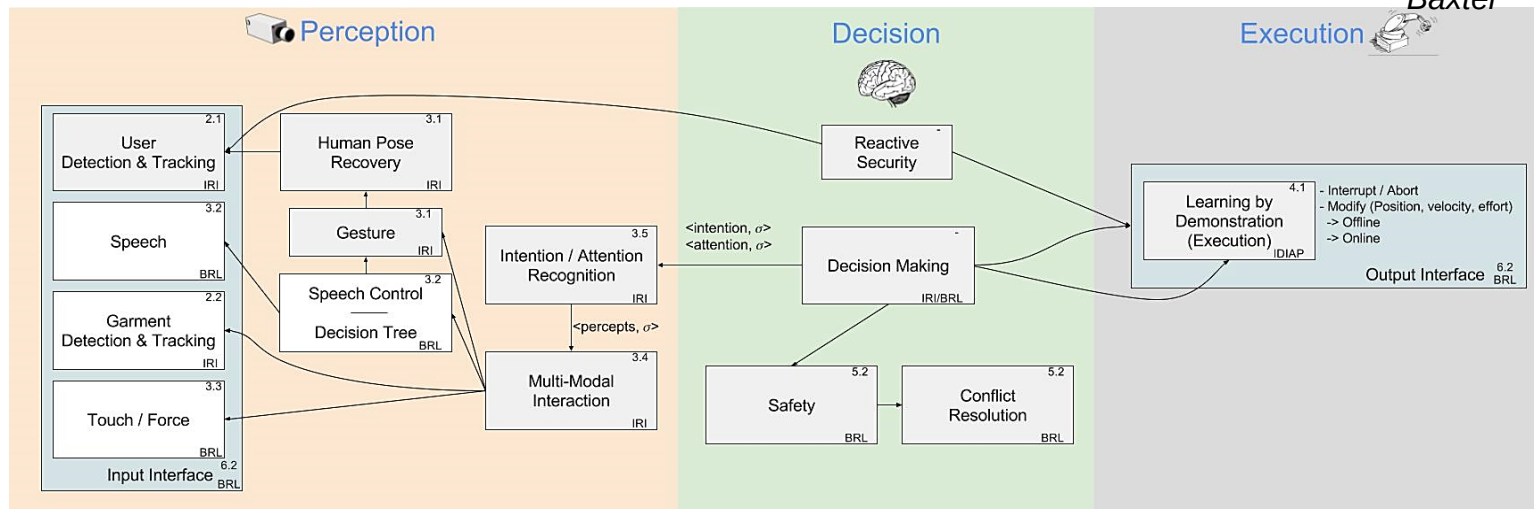
Barrett's WAM

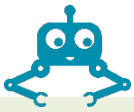
Robotic platforms



Rethink robotics'
Baxter

■ Overall architecture:





Key challenges and potential impact

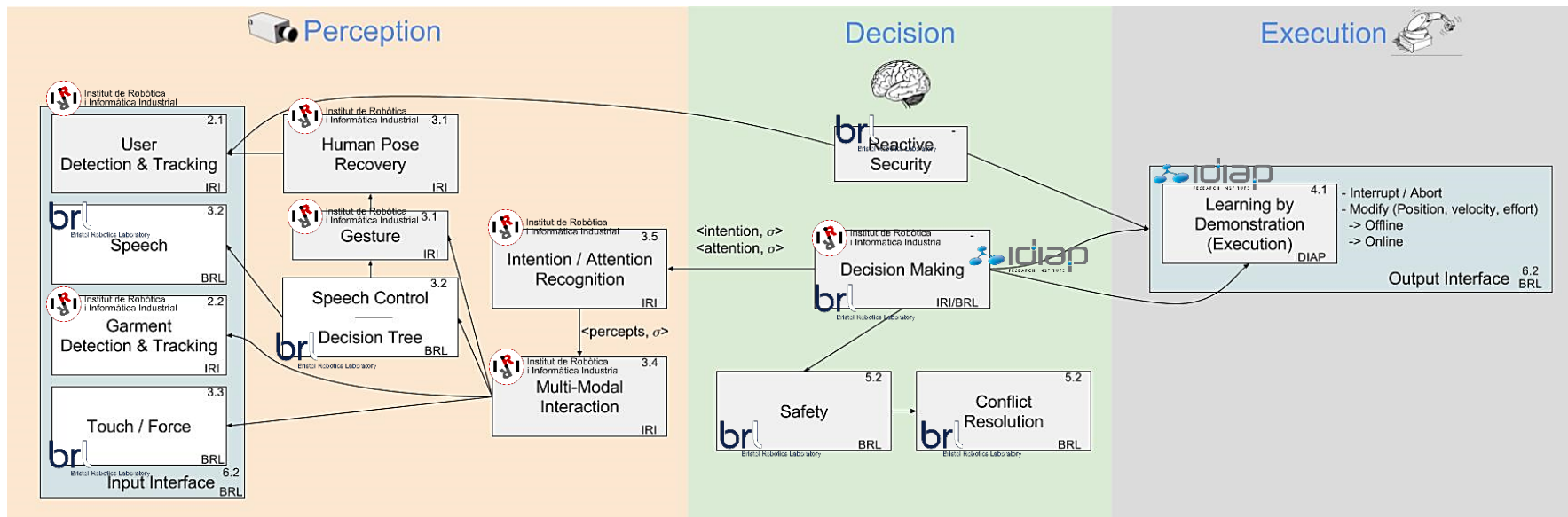
■ Expected impact:

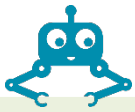
- The project aims at the **Technology Readiness Level 4**: Component/system validation in laboratory environment
- Advances are made in robot **perception**, **interaction**, **learning** and **safety**, with **user testing** in laboratory environment.
- **Robot personalization and adaptation** to specific user's needs, through interaction, is an important aspect of the project and it enlarges the scope of possible applications.
- Advancements in robot learning and task planning are used in similar robot configurations to **support other activities of daily living**, like feeding.
- Long-term impact in **reducing healthcare costs** by prolonging independent living and life quality of individuals previously reliant on carers.
- Final project developments will be done under the **Open Source policies**, and the use of the **ROS tools** will ensure their reusability.
- Dissemination among scientific community through **publications** (complete list is on the final slide)



Consortium

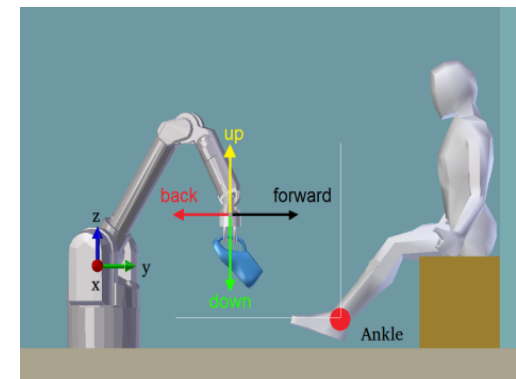
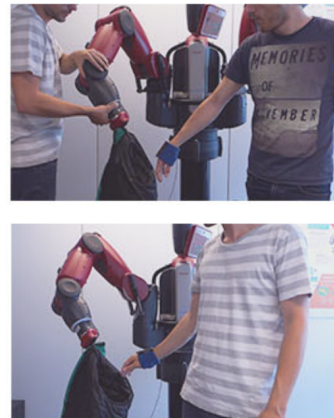
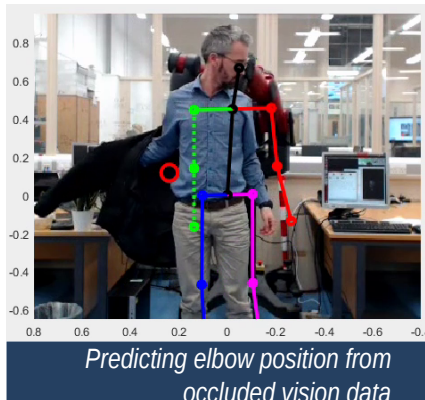
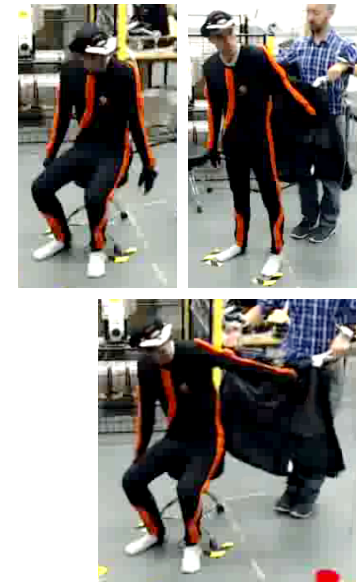
- **Institute of Robotics and Industrial Informatics, Spain**
 - Perception, multi-modal interaction, system integration
- **Bristol Robotics Laboratory, United Kingdom**
 - Safety, human factors, interface design
- **IDIAP institute, Switzerland**
 - Robot learning

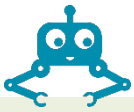




Main results

- Human-human interaction study
- Adaptation through multimodal interaction
- Robot learning and task planning
- Safety analysis

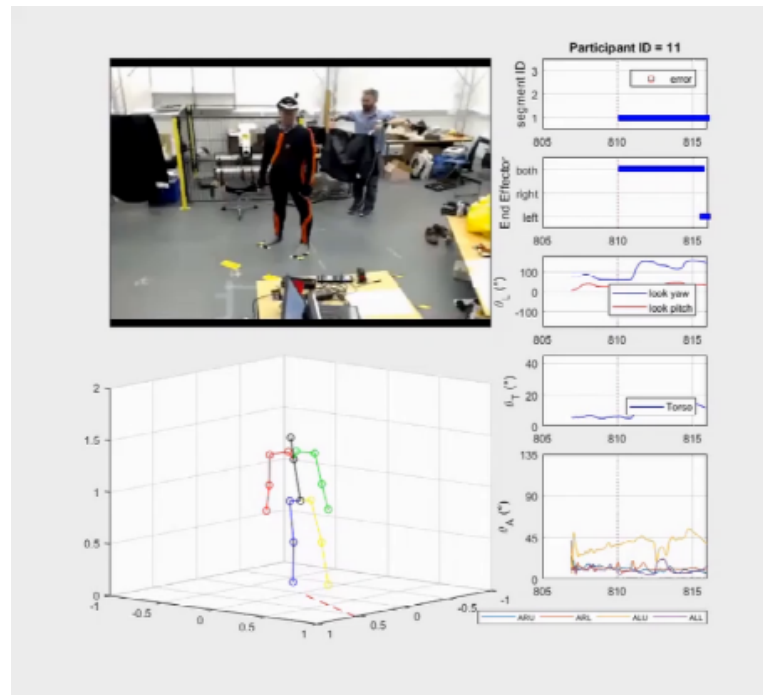




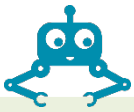
Main results

Human-human interaction study

- 18 participants performed in an assistive dressing task for jacket/shoe.
- Gathering a lot of sensors data.



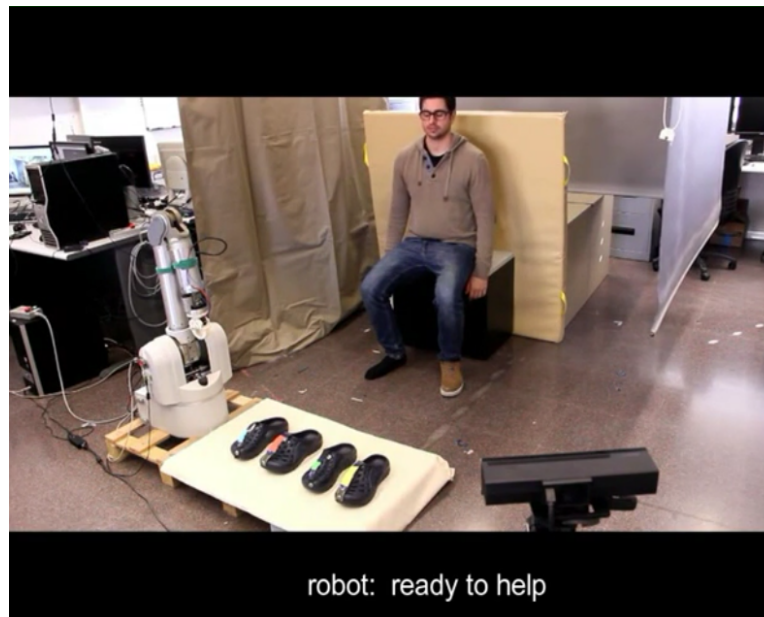
Video demo screenshot



Main results

Adaptation through multimodal interaction

- Use of different modalities: speech, gestures, leg postures.
- Personalization of the gesture recognition and shoe delivery adjustment.



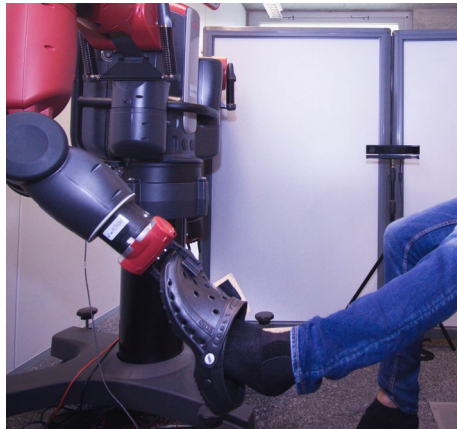
Video demo screenshot



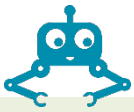
Main results

Task planning and robot learning

- Combined motion primitives and symbolic planning.
- Symbolic actions include user preferences and interactions, which are difficult to learn by demonstration.
- Motion primitives can cope with online variations.



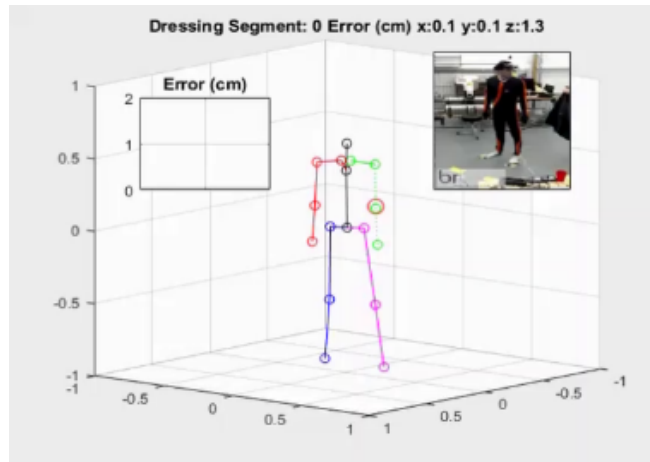
Video demo screenshot



Main results

Safety analysis

- Sensor data used to plan robot actions and improve user safety
 - Prediction of the elbow position during occlusion
 - Used for safer robot control
- 42 users performed robot-assisted dressing task with distractions:
 - Cognitive overload test, phone ringing, bystander question, radio-controlled mouse.
 - Observed significant change in user workload
- Data will be used for task planning



Video demo screenshot



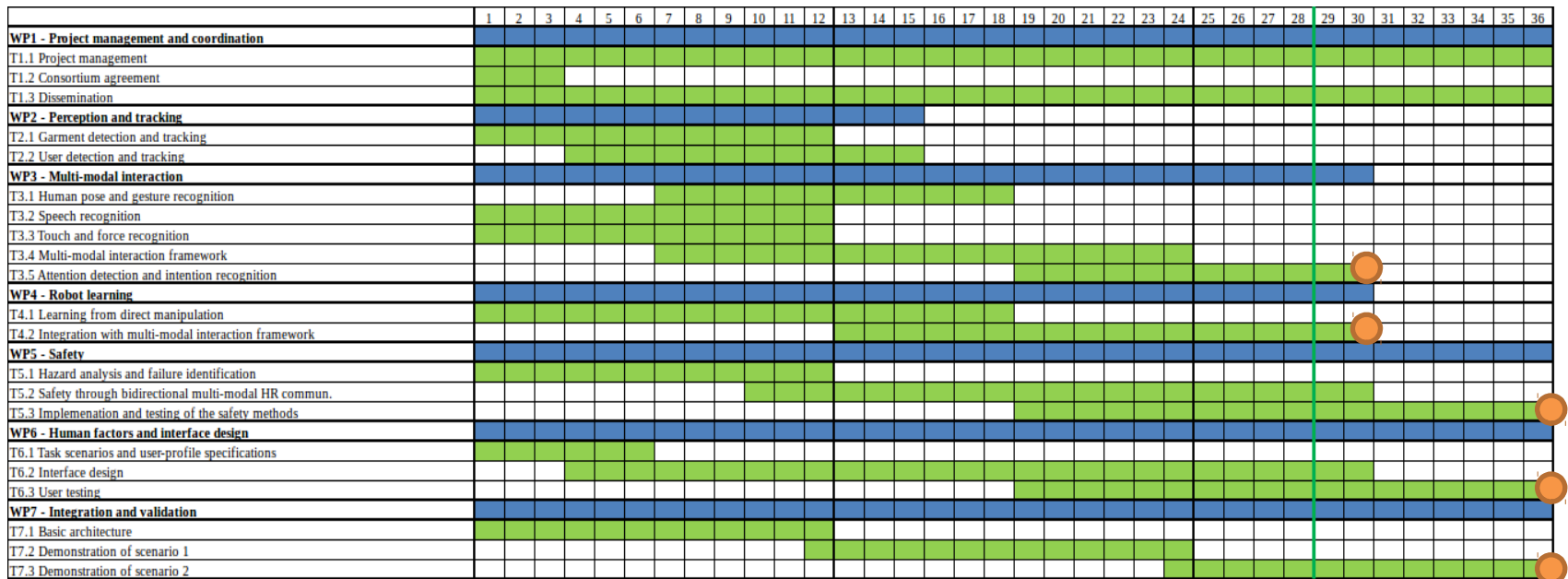
Video demo screenshot

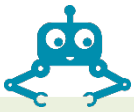


Remaining work

- Preparation for the final integration in June 2018
 - Demonstration of the jacket/gown scenario

- Gantt chart:

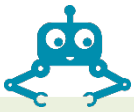




Publications

Journals

1. A. Jevtić, A. Flores, G. Alenyà, G. Chance, P. Caleb-Solly, S. Dogramadzi, and C. Torras. Personalized Robot Assistant for Support in Dressing. *IEEE Transactions on Cognitive and Developmental Systems*. In press. 2018
2. E. Corona, G. Alenyà, A. Gabás and C. Torras. Active garment recognition and target grasping point detection using deep learning. *Pattern Recognition*, 74:629-641, 2018.
3. E. Pignat and S. Calinon. Learning adaptive dressing assistance from human demonstration. *Robotics and Autonomous Systems*, 93:61-75, 2017.
4. A. Jevtić, A. Colomé, G. Alenyà and C. Torras. Robot motion adaptation through user intervention and reinforcement learning. *Pattern Recognition Letters*, In press. Available online: June 2017.
5. G. Chance, A. Jevtić, P. Caleb-Solly and S. Dogramadzi. A quantitative analysis of dressing dynamics for robotic dressing assistance. *Frontiers in Robotics and AI*, 4(13): 1-14, 2017.
6. M J A Zeestraten, I Havoutis, J Silverio, S Calinon and D G Caldwell. An Approach for Imitation Learning on Riemannian Manifolds. *IEEE Robotics and Automation Letters (RA-L)*, January 2017 .
7. A. Agudo, F. Moreno-Noguer, B. Calvo and J.M. Martínez. Real-time 3D reconstruction of non-rigid shapes with a single moving camera. *Computer Vision and Image Understanding*, 2016, to appear.
8. A. Ramisa, G. Alenyà, F. Moreno-Noguer and C. Torras. A 3D descriptor to detect task-oriented grasping points in clothing. *Pattern Recognition*, 60: 936-948, 2016.
9. F. Moreno-Noguer and J.M. Porta. A Bayesian approach to simultaneously recover camera pose and non-rigid shape from monocular images. *Image and Vision Computing*, 52: 141-153, 2016.
10. C. Torras. Service robots for citizens of the future. *European Review*, 24(1): 17-30, 2016.
11. J.G. Hoyos, F. Prieto, G. Alenyà and C. Torras. Execution Fault Recovery in Robot Programming by Demonstration Using Multiple Models. *IEEE Latin America Transactions*, 14(2): 517-523, 2016.
12. J.G. Hoyos, F. Prieto, G. Alenyà and C. Torras. Incremental learning of skills in a task-parameterized Gaussian mixture model. *Journal of Intelligent and Robotic Systems*, 82(1): 81-99, 2016.



Publications

Conferences

1. G. Canal, E. Pignat, G. Alenyà, S. Calinon and C. Torras. Joining high-level symbolic planning with low-level motion primitives in adaptive HRI: application to dressing assistance, 2018 IEEE International Conference on Robotics and Automation (ICRA), 2018, to appear.
2. G. Chance, P. Caleb-Solly, A. Jevtić and S. Dogramadzi. What's "up"? — Resolving interaction ambiguity through non-visual cues for a robotic dressing assistant, 26th IEEE International Symposium on Robot and Human Interactive Communication, 2017, Lisbon, Portugal, pp. 284-291.
3. F. Moreno-Noguer, 3D Human Pose Estimation from a Single Image via Distance Matrix Regression, Conference in Computer Vision and Pattern Recognition (CVPR), 2017.
4. G. Canal, G. Alenyà and C. Torras. A taxonomy of preferences for physically assistive robots, 26th IEEE International Symposium on Robot and Human Interactive Communication, 2017, Lisbon, Portugal, pp. 292-297.
5. S. Calinon. Stochastic learning and control in multiple coordinate systems. International Workshop on Human-Friendly Robotics (HFR), 2016.
6. A. Jevtić, A. Colomé, G. Alenyà, and C. Torras. User Evaluation of an Interactive Learning Framework for Single-Arm and Dual-Arm Robots. International Conference on Social Robotics (ICSR 2016), Kansas City, US, 2016. to appear.
7. G. Chance, A. Camilleri, B. Winstone, P. Caleb-Solly and S. Dogramadzi. An assistive robot to support dressing - strategies for planning and error handling. 2016 6th IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob), Singapore, 2016, pp. 774-780.
8. A. Gabás, E. Corona, G. Alenyà and C. Torras. Robot-aided cloth classification using depth information and CNNs, 9th Conference on Articulated Motion and Deformable Objects, 2016, Palma de Mallorca, Spain, in Articulated Motion of Deformable Objects, Vol 9756 of Lecture Notes in Computer Science, pp. 16-23, 2016, Springer.
9. A. Agudo and F. Moreno-Noguer. Recovering pose and 3D deformable shape from multi-instance image ensembles, 13th Asian Conference on Computer Vision, 2016, Taipei, Taiwan, Springer, to appear.
10. A. Agudo, J.M. Martínez, B. Calvo and F. Moreno-Noguer. Mode-shape interpretation: Re-thinking modal space for recovering deformable shapes, 2016 IEEE Winter Conference on Applications of Computer Vision, 2016, Lake Placid (USA), IEEE, to appear.
11. D. Martínez, G. Alenyà, C. Torras, T. Ribeiro and K. Inoue. Learning relational dynamics of stochastic domains for planning, 26th International Conference on Automated Planning and Scheduling, 2016, London, pp. 235-243.
12. A. Jevtić, A. Colomé, G. Alenyà and C. Torras. Learning Robot Motion through User Intervention and Policy Search. IEEE International Conference on Robotics and Automation (ICRA 2016), Workshop Nature versus Nurture in Robotics, Stockholm, Sweden, May 2016.



Dissemination activities

YEAR 1

- 01/03/2016 I-DRESS project website released: <https://i-dress-project.eu/>
- 12/06/2016 S. Calinon, Workshop on Planning, Scheduling and Dependability in Safe Human-Robot Interactions, Intl Conf. on Automated Planning and Scheduling (ICAPS'2016), London, UK.
- 13/06/2016 S. Calinon, Curzon-Goldsmiths Cinema, Goldsmiths University of London, UK.
- 11/09/2016 C. Torras, Press release, La Vanguardia.
- <http://www.lavanguardia.com/vida/20160911/41229579328/relaciones-humanos-robots.html>
- 10/10/2016 S. Calinon, Workshop on Human-Robot Collaboration: Towards Co-Adaptive Learning Through Semi-Autonomy and Shared Control, Intl Conf. on Intelligent Robots and Systems (IROS'2016), Daejeon, Korea.
- 05/11/2016 Press release, I-DRESS in El Periodico.
- <http://www.elperiodico.com/es/sociedad/20161105/robots-para-ensanchar-el-cerebro-5609134#>
- 10/11/2016 S. Calinon, "AI and Robotics: from technology to the arts" seminar, Mines-ParisTech, France.
- 22/11/2016 C. Torras, "Disenyant l'assistent perfecte: robòtica, ètica i literatura", Invited Talk, 60 years of AI, Lleida, Spain. https://twitter.com/acia_cat/status/800665618882134016
- 23/11/2016 S. Calinon, Learning dressing assistance task from demonstration, Swiss Machine Learning Day, EPFL.
- 09/12/2016 S. Calinon, Neurorobotics Workshop, 30th Annual Conference on Neural Information Processing Systems (NIPS'2016), Barcelona, Spain.
- 15/12/2016 S. Calinon, E. Pignat, Baxter le robot en formation, Press release, Le Nouvelliste.
- 18/12/2016 C. Torras, Press release, ARA Magazine.
- https://www.ara.cat/suplements/diumenge/moral-dels-robots_0_1707429244.html



Dissemination activities

YEAR 2

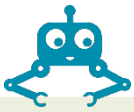
- 13/02/2017 C. Torras, "Els reptes de la robòtica assistencial", Talk as part of the public admission to the Royal Academy of Sciences and Arts of Barcelona. <http://www.racab.es/es/noticies/2017/2017-feb-13>
- 08/03/2017 C. Torras, "Designing the perfect assistant: Robotic AI, Ethics and Science Fiction", Invited Talk,
- Event: Artificial Intelligence: Dreams, risks and reality, International Center for Scientific Debate, CosmoCaixa, Barcelona, Spain
- <http://www.bdebate.org/en/video/designing-perfect-assistant-robotic-ai-ethics-and-science-fiction>
- 10/03/2017 Press release, Xornal de Galicia.
- 23/03/2017 P. Caleb-Solly, S. Dogramadzi, C. Torras, A. Jevtić, Workshop "Strategies for Deploying and Delivering Ethical, Sustainable and Acceptable Assistive Robotic Solutions", European Robotics Forum 2017, Edinburgh, UK.
- 04/2017 S. Calinon, Invited Talk, Autonomous Motion Department, Max Planck Inst. for Intelligent Systems, Tuebingen, Germany.
- 04/2017 S. Calinon, Invited Talk, Inst. of Robotics and Mechatronics, German Aerospace Center (DLR), Wessling, Germany.
- 09/04/2017 C. Torras, "Robótica asistencial: retos tecnocientíficos y éticos", Seminar and round table, Fundación Areces, Madrid, Spain.
- <https://fundacionareces.es/fundacionareces/cargarAplicacionAgendaEventos.do?verPrograma=1&idTipoEvento=1&identificador=2016>
- 24/04/2017 A. Jevtić, "Robot-Assisted Dressing", Seminar at the ABC Robotics Initiative, Ben-Gurion University, Israel.
- http://in.bgu.ac.il/en/robotics/Site%20Assets/Pages/seminars/Robot-Assisted_Dressing.pdf



Dissemination activities

YEAR 2

- 05/2017 S. Calinon, Invited Talk, Numerical Analysis Seminar, Mathematics Dept, University of Geneva.
- 23/06/2017 G. Chance, “Robotics assistants for the world’s ageing population?” talk, Science Café, Teignmouth, Devon, UK.
- 06/2017 S. Calinon, Invited Talk, Intelligent Autonomous Systems lab, TU Darmstadt.
- 06/2017 S. Calinon, Invited Talk, Gesture & Artificial Intelligence in Industry & Arts Think-Tank, Thessaloniki, Greece.
- 19/07/2017 C. Torras, TV C33: “El dia de demà: La familia del 2050”.
- <http://www.ccma.cat/tv3/el-dia-de-dema/la-familia-del-2050-en-12-frases/noticia/2800182/>
- 26/07/2017 C. Torras, “Robotic Dressing Assistants: Research, Ethics and Fiction”, Keynote Lecture at ICINCO 2017. <http://www.icinco.org/TechnicalProgram/View/TechnicalProgram.aspx>
- 08/2017 S. Calinon, Invited Talk, Tai Mountain Robotics Forum, Tai’An, China.
- 08/2017 S. Calinon, Invited Talk, Intl Conf. on Gesture and Speech in Interaction (INTERSPEECH’2017 satellite event), Poznań, Poland.
- 28-31/08/2017 G. Chance, European Robotic League (ERL 2017), Lisbon, Portugal. Member of the BRL Hearts team (<https://sites.google.com/site/erlslisbon2016june>).
- 09/2017 S. Calinon, Invited Talk, Workshop on Synergies Between Learning and Interaction, IEEE/RSJ IROS’2017, Vancouver, Canada.
- 09/2017 S. Calinon, Invited Talk, Workshop on Human in-the-loop robotic manipulation: on the influence of the human role, IEEE/RSJ IROS’2017, Vancouver, Canada.



Dissemination activities

YEAR 2

- 09/2017 S. Calinon, Invited Talk, Workshop on Learning for Collaborative Robotics: Enabling flexible, re-deployable and agile industrial applications, IEEE/RSJ IROS'2017, Vancouver, Canada.
- 10/2017 S. Calinon, Invited Talk, Intrinsically Motivated Open-ended Learning Workshop, Rome, Italy.
- 10/2017 S. Calinon, Invited Talk, Delft Workshop on Robot Learning, TU Delft, The Netherlands.
- 1-31/10/2017 G. Chance, "I'm an Engineer – Get me out of here!", a public engagement in UK schools, answering students' questions about engineering and the career of scientists and engineer. Dr Chance came in 2nd place, narrowly missing out on the top spot and £500 prize to spend on outreach activities.
- 11/2017 S. Calinon, Invited Talk, Small data: challenges and opportunities, Valais/Wallis Workshop on Artificial Intelligence, Martigny, Switzerland.
- 14/11/2017 C. Torras, S. Foix, TV3 "Sense Ficció". <http://www.ccma.cat/tv3/alacarta/sense-ficcio/treballar-despres-de-la-crisi/video/5701210/>
- 29/11/2017 C. Torras, "Joves, Ciència i Ètica", Final Project meeting al Cosmocaixa, Edition 2017/2018.
- <http://www.fundaciorecerca.cat/ca/edicio-2017-2018>
- 12/01/2018 C. Torras, Press release, El Mundo (El Cultural).
- <https://acceso360.acceso.com/upc/es-ES/?mod=TrackingPressViewer&task=default&external=1&companyNewsId=470256540&newsDate=1515711600&sig=565e92bf211e1be67c7d572dd2d6925f6e71668b9a23331720105866d9a51bdb>
- 12/2017 S. Calinon, Invited Talk, Intl workshop on representation, analysis and recognition of shape and motion from image data, Aussois, France.